STATE OF COLORADO

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Dedicated to protecting and improving the health and environment of the people of Colorado

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Colorado Department
of Public Health
and Environment

December 21, 2012

Jim Martin
National Sales Director
Lemna Technologies, Inc.
2445 Park Avenue
Minneapolis, MN 55404

Subject: Acceptance of the Lemna Polishing Reactor as an Alternative Technology for Use in Domestic Wastewater Treatment Works in Colorado

Dear Mr. Martin:

The Water Quality Control Division (the Division) has received and reviewed information for the Lemna Polishing Reactor (LPR) in accordance with Section 1.8.0 of *Design Criteria for Domestic Wastewater Treatment Works Policy WPC-DR-1* (Wastewater Design Criteria). The LPR design is accepted for use as an Alternative Technology subject to the design criteria in Table 1.

This acceptance addresses the following item:

- Lemna Polishing Reactor for nitrification using synthetic media modules.

This acceptance applies only to the Lemna Technologies, Inc. Lemna Polishing Reactor and does not constitute construction approval for installation in domestic wastewater treatment facilities. **Review and approval for the design of any domestic wastewater facility proposing to use this technology will be further reviewed on a site-specific basis by the Division** as required by Section 22.11(1) of the *Site Location and Design Approval Regulations for Domestic Wastewater Treatment Works 5CCR 1002-22* (Regulation 22) and the Colorado Water Quality Control Act (Act), Section 25-8-702, C.R.S. which states in part that: *"No person shall commence the construction of any domestic wastewater treatment works or the enlargement of the capacity of an existing domestic wastewater treatment works, unless the site location and the design for the construction or expansion have been approved by the division."*

Any modifications to the physical attributes or characteristics of this treatment technology must be submitted to this office for review and acceptance by the Division prior to installation at a domestic wastewater treatment works in Colorado. This condition includes changes made to the LPR (e.g., media, piping, mechanisms). The Division will review any additional third party verification reports and issue a revised acceptance letter, or denial, as appropriate.

Table 1. Lemna Technologies Lemna Polishing Reactor Design Criteria:

Design Criteria
1. Colorado's current wastewater design criteria do not contain criteria specific to the design of the LPR components for fixed biofilm nitrification in a wastewater treatment system. This acceptance is directed at the use of the synthetic media modules for the biofilm nitrification process. Criteria for the complete secondary treatment in the preceding lagoons are currently included in the wastewater design criteria.
2. Unit process design shall be established in accordance with current Colorado wastewater design criteria at the time of the design submittal and this acceptance for items not in the design criteria. During the site-specific design review, calculations shall be submitted to justify the basis of design for the biological and secondary processes including, but not limited to, aeration basins/lagoons, aeration, mixing, and settling. The aeration system design shall provide sufficient air transfer using an appropriate α-value and provide sufficient oxygen for carbonaceous and nitrification oxygen demand.
3. LPR facility design capacity shall be based on the maximum monthly average flow and loading. LPR unit process sizing for nitrification shall be established at a rate of no more than 1 g TKN/m^2/day (0.2 lb TKN/1000 sf/day) at a wastewater temperature of at least 20°C. Adjustments may be needed as noted in item 9 below for colder wastewater temperatures within the LPR (e.g., seasonal, following lagoons). The design hydraulic retention time (HRT) in the LPR shall be at least 3 hours.
4. Treatment must occur in other unit processes prior to nitrification in the LPR including screening with a bar screen at a spacing of 0.5 inches or less, secondary treatment to reduce BOD to a concentration of less than 30 mg/L, settling to remove TSS to a concentration of less than 30 mg/L, and removal of oil, grease, scum, grit, and floating debris. LPR synthetic media may be used to reduce BOD concentrations. LPR unit process sizing for BOD reduction shall be established at a rate of no more than 0.77 kg BOD_5/m^3/day (48 lb BOD_5/1000 cf/day).
5. If multiple trains are included in parallel, adequate flow splitting devices must be provided to ensure control of flow to each unit.
6. Treatment Credit. The domestic wastewater treatment plant must meet appropriate effluent discharge limits (e.g., Preliminary Effluent Limits or PELs, permit effluent limits) as justified in the design basis noted in item 2 above. Nitrification credit shall be granted within the LPR process at the point when sufficient prior design capacity (lagoons and LPR) is provided to reduce the design BOD_5 concentration to zero. No denitrification credit or phosphorus removal credit is granted for the LPR treatment technology.
7. Aeration Equipment. Aeration equipment shall be provided. The design must demonstrate adequate size and capacity based on site-specific conditions and treatment requirements including, but not limited to, elevation, temperature (e.g., seasonal, air, wastewater), pipe sizes, bends, etc.
8. Alkalinity. Nitrification requires alkalinity, 7.14 pounds as $CaCO_3$ per pound ammonia oxidized. The wastewater must be shown to have sufficient alkalinity (i.e., 50 mg/L excess) or chemical treatment must be included to provide adequate alkalinity.
9. Temperature adjustments. Design values are based on a wastewater temperature of 20°C. Treatment rates (i.e., nitrification) shall be adjusted for anticipated wastewater temperatures below 20°C by the following: ammonia loading at temperature T = ammonia loading limit at 20 °C x (1.058^{T-20}) [from WEF, MOP 35, Biofilm Reactors, 2010, Table 5.6].
10. For facilities where ambient temperatures can be below freezing, the design shall include adequate cold weather provisions (e.g., heat trace lines, insulated covers, installation in a temperature-controlled enclosure for above ground wet components).

11. A solids separation process or device (e.g., effluent screen, filter) is required following the LPR unit and before discharge (e.g., effluent screen or filter device, tank following the last treatment stage for settling and an effluent filter device, pump tank with settling and a screening device around the pump or pumps).
12. Site pretreatment processes shall be incorporated into the process train, as required, to ensure that anticipated peak loads (e.g., hydraulic, organic, nutrient) are accommodated and mitigated to maintain treatment performance. Flow equalization must be provided when large fluctuations day to day are anticipated (e.g., church).
13. Alarm. A blower malfunction alarm must be provided. The design must identify how the alarm signal will notify operators of alarm activations, when the facility is attended and unattended.
14. Design Redundancy. At least two equal trains of LPR systems (i.e., separate functionality for controls, blowers) shall be installed, each with a design flow of at least 50 percent of the total design capacity. Fixed capacity (i.e., all units operating) for aeration capacity shall be capable of providing design requirements (e.g., enable the design oxygen transfer). Firm capacity (i.e., largest unit out of service) for aeration capacity shall be available at the site to provide design requirements (e.g., enable the design oxygen transfer). It is permissible for the backup unit to be an uninstalled unit, provided the installed unit can be easily removed and replaced. The air diffusion system for a LPR system shall be designed such that perforated aeration piping for a media stack can be isolated without significantly impairing the oxygen transfer capability of the remainder of the LPR system.
15. Other Processes Required. Although the LPR treatment technology has major unit process components of a treatment plant, it does not constitute a complete package treatment plant and the particular site-specific design must include other unit processes (e.g., influent and effluent flow metering, secondary treatment, chemical addition, disinfection, phosphorus removal) to be a fully functioning wastewater treatment plant and meet effluent discharge limits.
16. Tank Design. Design must include adequate provisions to protect against tank buoyancy.
17. Maintenance Access. Design shall include provisions that allow the operator to access, operate, and maintain the treatment technology.
18. Manufacturer Review. A review letter issued by the manufacturer indicating the installation was designed in accordance with manufacturer recommendations must be included with the site-specific design submittal. The manufacturer's review may not supersede criteria in this acceptance. The manufacturer's review may not be substituted for all required engineering documentation and calculations stamped and signed by a Colorado licensed Professional Engineer.

Additional Operations and Maintenance Criteria

1. Design must include discussion of residuals management considerations, including the management of mixed liquor concentration, the expected solids generation quantities and quality, and a discussion of the method of final sludge disposal, if applicable.
2. Design shall include provisions for initial operator training. An Operations and Maintenance (O&M) Manual shall be provided for all installations. The document should be available for review by the Division during compliance inspections.
3. Certified Operator. The domestic wastewater treatment works with this technology will be required to be under the control of an operator with a Class C or Class B Domestic Wastewater Treatment Facility Certification, depending upon the system complexity and sensitivity of the receiving water, in accordance with Regulation 100 Water and Wastewater Facility Operators Certification Requirements.

The owner of the domestic wastewater treatment works is responsible for proper design, operation, and maintenance of the facility to meet permit effluent requirements.

Please be aware that any point source discharges of water from treatment facilities are potentially subject to a discharge permit under Colorado's State Discharge Permit System. Any point source discharges to state waters without a permit are subject to civil or criminal enforcement action.

As part of this review, the Division has evaluated the following documents:

- June 13, 2012 Submittal from The Farnsworth Group requesting new technology acceptance for Lemna Polishing Reactor.
- June 29, 2012 Submittal from The Farnsworth Group, providing additional information for the new technology review for the Lemna Polishing Reactor.
- Various additional correspondences.

Please direct any further correspondence regarding this acceptance to:

David Kurz, P.E.
Colorado Department of Public Health and Environment
Water Quality Control Division
4300 Cherry Creek Drive South
Denver, CO 80246

If you have any questions or comments, please contact David Kurz at david.kurz@state.co.us or 303-692-3552.

Sincerely,

David Kurz, P.E.
Lead Wastewater Engineer
Engineering Section
Water Quality Control Division